U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-257 324

# Alternatives to Secondary Sewage Treatment Offer Greater Improvements in Missouri River Water Quality

Comptroller General of the United States, Washington, D C

Prepared for

Environmental Protection Agency, Washington, D C

6 Jan 72

260002

PB 257 324

# REPORT TO THE CONGRESS

## Alternatives To Secondary Sewage Treatment Offer Greater Improvements In Missouri River Water Quality

B-129043

Environmental Protection Agency

*BY THE COMPTROLLER GENERAL OF THE UNITED STATES*

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

JAN. 6, 1972

| BIBLIOGRAPHIC DATA SHEET | 1. Report No. B-125042 | 2. | 3. Recipient's Accession No. PB-257 324 |
|---|---|---|---|
| 4. Title and Subtitle<br>Alternatives to Secondary Sewage Treatment Offer Greater Improvements in Missouri River Water Quality. | | | 5. Report Date<br>January 6, 1972<br>6. |
| 7. Author(s) | | | 8. Performing Organization Rept. No. |
| 9. Performing Organization Name and Address<br>Comptroller General of the United States<br>Washington, D. C. | | | 10. Project/Task/Work Unit No.<br>11. Contract/Grant No. |
| 12. Sponsoring Organization Name and Address | | | 13. Type of Report & Period Covered<br>14. |

15. Supplementary Notes
Prepared in cooperation with Environmental Protection Agency.

16. Abstracts The General Accounting Office (GAO) has made this review because extensive Federal funds will be involved in pollution control projects along the Missouri River. The Environmental Protection Agency (EPA) is authorized to award grants to States and municipalities for constructing sewage treatment facilities if enforceable water quality standards have been established. The legislation empowering the grants does not specify the minimum levels of sewage treatment necessary to meet the water quality standards. EPA, however, is requiring the States along the Missouri River to provide secondary sewage treatment by 1975 for municipal wastes entering the river. The principal purposes of sewage treatment are (1) to keep enough disolved oxygen in the water to support aquatic life and (2) to prevent offensive conditions. To enforce its requirements, EPA has advised State and local officials that the Federal Government will not participate in the cost of constructing sewage projects along the river unless the States include secondary treatment in their water pollution control programs.

17. Key Words and Document Analysis. 17a. Descriptors

*Sewage treatment
*Project management
*Missouri River
Recreation
Fishing
Oxygen
National government
State government
Construction

17b. Identifiers/Open-Ended Terms

Secondary sewage treatment

17c. COSATI Field/Group 13B, 8H

18. Availability Statement
National Technical Information Service
Springfield, VA 22161

19. Security Class (This Report) UNCLASSIFIED
21. No. of Pages 58
20. Security Class (This Page) UNCLASSIFIED
22. Price PC$4.50/MF$2.25

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-125042

To the President of the Senate and the
Speaker of the House of Representatives

This is our report on alternatives to secondary sewage treatment which offer greater improvements in Missouri River water quality. Federal participation in pollution control projects along the Missouri River is administered by the Environmental Protection Agency.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Office of Management and Budget, and to the Administrator, Environmental Protection Agency.

Elmer B. Staats

Comptroller General
of the United States



50TH ANNIVERSARY 1921 - 1971

# Contents


| | | Page |
|---|---|---|
| DIGEST | | 1 |
| CHAPTER | | |
| 1 | INTRODUCTION | 5 |
| 2 | IMPLEMENTATION OF ENVIRONMENTAL PROTECTION AGENCY POLICY ALONG MISSOURI MAIN STEM | 9 |
| | Improvement of water quality by treatment plants | 9 |
| | Actions to persuade States to adopt secondary treatment as standard | 11 |
| | Suggested alternative to adoption of secondary treatment as standard | 13 |
| 3 | SUITABILITY OF MISSOURI RIVER FOR ITS APPROVED USES | 14 |
| | Recreational use | 14 |
| | Use for public water supply | 17 |
| | Commercial fishing | 18 |
| 4 | LIMITED BENEFITS FROM CONSTRUCTION OF SECONDARY TREATMENT PLANTS | 19 |
| | Impact on oxygen content of main stem | 19 |
| | Impact on disease-producing bacteria | 20 |
| | Agriculture-related pollution | 24 |
| | Silt from soil erosion and sedimentation | 24 |
| | Pesticides | 25 |
| | Organic wastes from large feeding operations | 25 |
| | Priority given secondary treatment will delay more urgently needed projects | 26 |
| 5 | FEDERAL AND STATE COMMENTS AND OUR EVALUATIONS | 29 |
| | Written comments of Environmental Protection Agency | 29 |
| | Subsequent meeting with Deputy Assistant Administrator of Environmental Protection Agency | 33 |

| CHAPTER | | Page |
|---|---|---|
| 6 | CONCLUSIONS AND RECOMMENDATIONS | 34 |
| | Conclusions | 34 |
| | Recommendations | 35 |
| 7 | SCOPE OF REVIEW | 36 |
| APPENDIX | | |
| I | Evaluation of deferred costs for upgrading treatment plants | 37 |
| II | Status of research on pollution from Agricultural sources | 41 |
| III | Agency and State comments | 44 |
| IV | Principal officials of the Environmental Protection Agency responsible for administration of activities discussed in this report | 50 |
| ILLUSTRATIONS | | |
| | Region surrounding Missouri River main stem | 5 |
| | Graph showing operating costs relative to percent removal of oxygen-demanding wastes | 10 |
| | Graph showing dissolved-oxygen concentrations found in both dry- and wet-weather periods | 16 |
| | Graph showing measured and predicted coliform concentration | 23 |

## ABBREVIATIONS

| | |
|---|---|
| ARS | Agricultural Research Service |
| EPA | Environmental Protection Agency |
| GAO | General Accounting Office |
| HUD | Department of Housing and Urban Development |
| O&M | operating and maintenance |
| PE | population equivalent |
| PHS | Public Health Service |

## GLOSSARY OF

## SEWAGE TREATMENT TERMINOLOGY

Algae are plants which grow in sunlit waters. They are a food for fish and small aquatic animals and, like all plants, put oxygen in the water during the hours they receive light. When they die they exert a biochemical oxygen demand.

Assimilative capacity is the natural ability of the waters to receive and decompose organic wastes without seriously depleting the dissolved oxygen.

Biochemical oxygen demand is a measure of organic waste load which indicates the amount of oxygen drawn upon in the process of decomposition of the waste.

Coliform group organisms are groups of widely occurring bacteria used as indicators of biologic contamination of water. Total coliform bacteria are contained in large numbers in fecal wastes but also may come from sources other than sewage. Fecal coliform bacteria are that part of the coliform population having a specific high order of positive correlation with warm-blooded animals.

Combined sewers carry both sewage and storm water runoff. In a combined system some of the sewage is allowed to flow directly into a receiving stream during heavy rainfall. This protects the treatment plant from being overloaded from a sudden surge of water into the sewers.

Dissolved oxygen is gaseous oxygen in the water which is not chemically combined with other substances. A sufficient quantity must be available in water if oxygen-demanding materials are to be assimilated.

Effluent is the liquid that comes out of a treatment plant after completion of the treatment process.

Interceptor sewers are used in sanitation systems to carry the flows from main and trunk sewers to the sewage treatment plant.

Pathogenic bacteria are disease-causing bacteria.

Pollution results when unwanted animal, vegetable, or mineral matter reaches water and makes the water more difficult or dangerous to use for drinking, recreation, agriculture, industry, or wildlife.

Primary sewage treatment is the use of filtering and sedimentation techniques to remove about 30 percent of biological oxygen-demanding wastes.

Sanitary sewers, in a separate system, carry only domestic waste water. The storm water runoff is taken care of by a separate system of pipes.

Secondary sewage treatment is the use of biological processes to accelerate the decomposition of sewage and to thereby reduce oxygen-demanding wastes by 80 to 90 percent.

Storm sewers are a separate system of pipes that carry runoffs from buildings, streets, and land during a storm.

Suspended solids are the wastes that will not sink or settle.

Turbidity is a measure of the clarity and light penetration of water as affected by suspended and colloidal matter.

*COMPTROLLER GENERAL'S REPORT TO THE CONGRESS*

# ALTERNATIVES TO SECONDARY SEWAGE TREATMENT OFFER GREATER IMPROVEMENTS IN MISSOURI RIVER WATER QUALITY

Environmental Protection Agency B-125042

## D I G E S T

### *WHY THE REVIEW WAS MADE*

The General Accounting Office (GAO) has made this review because extensive Federal funds will be involved in pollution control projects along the Missouri River.

#### *Background*

The Environmental Protection Agency (EPA) is authorized to award grants to States and municipalities for constructing sewage treatment facilities if enforceable water quality standards have been established. The legislation empowering the grants does not specify the minimum levels of sewage treatment necessary to meet the water quality standards. EPA, however, is requiring the States along the Missouri River to provide secondary sewage treatment by 1975 for municipal wastes entering the river.

The principal purposes of sewage treatment are (1) to keep enough dissolved oxygen in the water to support aquatic life and (2) to prevent offensive conditions. In a secondary treatment plant, the biological processes which occur naturally in a river are accelerated so that decomposition of sewage occurs more rapidly. Secondary sewage treatment is used as a supplement to primary sewage treatment which uses filtering and sedimentation techniques to remove wastes from sewage. The cost of providing secondary treatment along the Missouri main stem is estimated at $206 million.

To enforce its requirements, EPA has advised State and local officials that the Federal Government will not participate in the cost of constructing sewage projects along the river unless the States include secondary treatment in their water pollution control programs.

### *FINDINGS AND CONCLUSIONS*

GAO believes that water pollution control programs along the Missouri River main stem would be more effective if available Federal funds were used to construct or improve primary treatment plants and sewer systems to prevent raw sewage from entering the river rather than to provide secondary treatment at this time.

Tests have shown that the dissolved-oxygen levels in the Missouri River currently are above the minimum required by State standards. However,

JAN. 6,1972

untreated sewage producing offensive conditions is pouring directly into the river at certain locations.

Primary treatment which removes solid wastes is the most effective method of eliminating these conditions and could provide the most immediate benefits. Pollution problems are complicated during heavy rains, when the amount of untreated wastes poured into the river increases greatly. During rainy weather the increased flow through the sewer systems exceeds the operating capacity of the treatment facilities. When this happens, sewage--still untreated--is allowed to flow directly into the river. At the same time the rain causes increased agricultural runoff which feeds fertilizers, pesticides, and organic wastes into the river.

Many projects for constructing or improving primary treatment facilities or interceptor sewers to channel sewage to primary treatment plants are being delayed until after 1975, to concentrate on providing secondary treatment, as required by EPA.

## *RECOMMENDATIONS OR SUGGESTIONS*

The Administrator of EPA should reconsider the timing of the requirement for secondary treatment of municipal wastes along the Missouri River. Such reconsideration should be made in the light of conditions existing along the river and the nature of the sources of its pollution. The Administrator should also evaluate whether greater public benefits are attainable sooner from expenditures for pollution abatement projects other than secondary treatment plant construction.

## *AGENCY ACTIONS AND UNRESOLVED ISSUES*

EPA now has agreed that, given a limited amount of funds, the conditions existing in the river, its sources of pollution, and the intended uses of the water should be considered in determining the level of treatment required. GAO has not been informed, however, of actions which the agency may be planning on the basis of this agreement.

State and local officials with whom GAO discussed the matter agreed that construction of secondary treatment plants would divert funds from other projects which might provide more immediate results.

GAO plans to continue to look into EPA's efforts in dealing with pollution caused by agricultural runoff and bypassing of sewage treatment facilities.

## *MATTER FOR CONSIDERATION BY THE CONGRESS*

If pending legislation (S. 2770, 92d Cong., 1st sess.) were to become law, substantially greater appropriations would be authorized and it would be possible to achieve higher levels of treatment sooner than under

present legislation. Until such time as greater resources are made available, the Congress may wish to inquire into the actions taken by EPA regarding the program for pollution abatement along the Missouri River.

# CHAPTER 1

## INTRODUCTION

The General Accounting Office has reviewed and evaluated the Environmental Protection Agency[1] policies and practices for attaining the water quality objectives adopted for the Missouri River. Our review was concerned with the Missouri River from Gavin's Point, South Dakota, to St. Louis, Missouri, referred to here as the main stem. We examined into the desirability of expending limited funds to provide secondary municipal waste treatment. In making our review, we were assisted in certain technical matters by consultants having expertise in various fields related to pollution abatement.

The illustration below is a sketch map of the Missouri main stem and surrounding areas.

[1] Federal water pollution control activities were under the Department of the Interior and were carried out by the Federal Water Quality Administration. The Federal Water Quality Administration, however, together with other environmental agencies and their respective functions, was incorporated into the newly established EPA, effective December 2, 1970. In this report EPA is used throughout to refer to both the current and the predecessor organizations.



ceding page blank

The Federal Water Pollution Control Act of 1956, as amended in 1965 (33 U.S.C. 466), states that it is the policy of the Congress to (1) recognize, preserve, and protect the primary responsibilities of the States in preventing and controlling water pollution, (2) support and aid technical research, and (3) provide Federal technical services and financial aid to State, interstate, and municipal agencies concerned.

The act requires the Administrator of EPA to cooperate with Federal, State, interstate, and municipal agencies in developing comprehensive programs for eliminating or reducing the pollution of interstate waters. The act requires also the Administrator to consider improvements which are necessary to enhance and conserve the water for public water supplies, propagation of fish and other aquatic life, recreation, and other legitimate uses.

As amended, the act provides for the States to establish standards for the prevention, control, and abatement of pollution. The act further stipulates that the standards include three essentials: (1) a determination of legitimate water uses, (2) the limits of pollutants legally allowable to obtain these uses, and (3) a provision for adequate sewage treatment, including implementation dates. The States were given until June 30, 1967, to submit such standards to the Secretary of the Interior. Upon his approval the standards became legally enforceable State and Federal goals.

Under legislation now pending, the act would be revised substantially to change water pollution control policy from a water quality standards control policy to a discharge control policy. In furtherance of the policy, all publicly owned sewage treatment works would be required to utilize secondary treatment by 1976.

EPA is authorized to award grants to any State or municipality for constructing necessary treatment facilities to prevent the discharge of untreated or inadequately treated sewage or other waste into interstate waters. Federal and State planning for water pollution control is required before approval of the grants. States must certify that projects are entitled to priority over other eligible water pollution control projects.

In approving Federal financial aid for waste treatment facilities, the public benefits to be derived from such facilities in relation to their construction and maintenance costs must be considered. Section 8(c) of the act states, in part, that:

> "(c) In determining the desirability of projects for treatment works and of approving Federal financial aid in connection therewith, consideration shall be given by the Administrator to the public benefits to be derived by the construction and the propriety of Federal aid in such construction, the relation of the ultimate cost of constructing and maintaining the works to the public interest and to the public necessity for the works, and the adequacy of the provisions made or proposed by the applicant for such Federal financial aid for assuring proper and efficient operation and maintenance of the treatment works after completion of the construction thereof."

The act permits Federal financial assistance equal to 30 percent of the estimated project costs. This may increase to 50 percent if a State agrees to pay at least 25 percent of all such project costs and if enforceable water quality standards have been established. The Federal share can be increased by an additional 10 percent of the grant (to 33 percent or to 55 percent of costs) if the project is in conformity with a metropolitan or regional plan for the area concerned.

Under the pending amendments to the act, the basic Federal share would be increased to 60 percent. A further 10-percent Federal bonus is provided when the State agrees to contribute 10 percent. Thus the municipal share may be as low as 20 percent.

In the EPA Missouri Basin Region, the States authorizing matching funds of 25 percent of the total project costs are Missouri, Nebraska, and Iowa. Therefore cities in these States need raise only 25 percent of the total project costs if Federal and State appropriations are adequate, whereas cities in other Missouri Basin States that are not

in conformity with a metropolitan or regional plan must raise a minimum of 70 percent of the costs.[1]

As of June 30, 1971, the eight Missouri Basin States had received about $191 million in grants. The four States bordering the Missouri main stem received about $15.1 million of this total. During fiscal years 1965 to 1971, these four States initiated 827 pollution abatement projects involving costs of $442.2 million eligible for Federal participation. Federal grants to these States during this period totaled $122.6 million, as follows:

| | Number of projects | Eligible costs | EPA grants |
|---|---|---|---|
| | | (millions) | |
| Kansas | 188 | $ 79.0 | $ 22.2 |
| Missouri | 184 | 183.0 | 40.8 |
| Iowa | 250 | 111.7 | 37.3 |
| Nebraska | 205 | 68.7 | 22.3 |
| Total | 827 | $442.4 | $122.6 |

[1]There are 15 metropolitan or regional plans in effect in the four States on the main stem.

## CHAPTER 2

## IMPLEMENTATION OF ENVIRONMENTAL PROTECTION AGENCY POLICY ALONG MISSOURI MAIN STEM

Although EPA does not have a written policy requiring the construction of secondary treatment plants, it has advised State and local officials that the Federal Government will not participate in the cost of constructing sewage projects along the Missouri main stem unless State plans provide for secondary treatment by about 1975. EPA has estimated that it will cost about $206 million to upgrade existing treatment facilities (mainly primary treatment plants) to provide secondary treatment along the main stem. The $206 million does not include annual operating and maintenance costs which will be significantly higher for secondary treatment plants than for primary.

A number of State and local water pollution control officials advised us that they were reluctant to construct secondary treatment plants along the main stem because secondary treatment of wastes would have little effect on the quality of the water and would divert limited resources from other projects which could provide more immediate pollution abatement. (See ch. 4.)

### IMPROVEMENT OF WATER QUALITY BY TREATMENT PLANTS

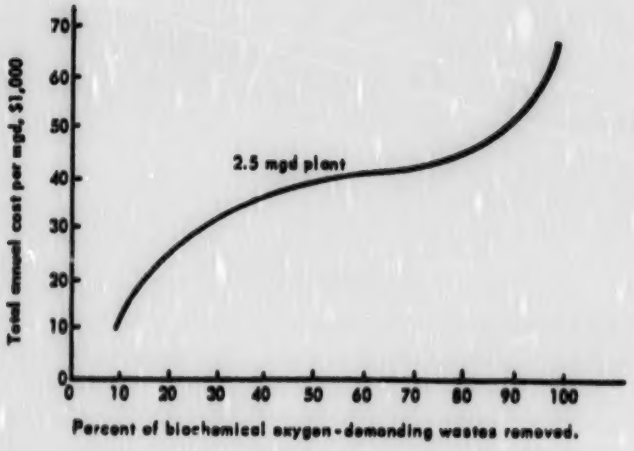
Sewage treatment consists of a number of mechanical, chemical, and biological processes that are combined or staged to remove various wastes to the levels desired. Normally certain of these processes are combined in a single plant to produce increasing levels of treatment known as primary, secondary, and tertiary (advanced) waste treatment. Generally the communities in the four States included in our review are operating primary treatment plants along the main stem and secondary treatment plants on the tributaries to the main stem.

Historically the need for sewage treatment has been based on the lack of sufficient dissolved oxygen in the receiving waters. Oxygen in water is necessary to propagate

aquatic life and to prevent a stream from stinking or being unsightly. The oxygen is depleted when sewage decomposes in the waters but is restored through natural aeration. Thus the dissolved-oxygen content is a balance between these processes.

Primary sewage treatment ordinarily removes the larger suspended solids by screens and grit chambers and by sedimentation. When operated efficiently, primary treatment plants reduce the biochemical oxygen-demanding wastes about 30 percent. A next step, secondary sewage treatment, uses a biological process that accelerates the decomposition of sewage. Secondary sewage treatment can reduce the oxygen-demanding wastes in sewage about 80 to 90 percent.

Through a still higher level of treatment (tertiary), oxygen-demanding wastes can be reduced 95 to 98 percent. Operating costs increase rapidly, however, as greater amounts of oxygen-demanding wastes are removed from the sewage through treatment. This is illustrated in the following graph.[1]




[1] Source: "Managing Water Quality: Economics, Technology, Institutions," Allen V. Knees and Blair T. Bower.

## ACTIONS TO PERSUADE STATES TO ADOPT SECONDARY TREATMENT AS STANDARD

To comply with the Water Quality Act of 1965, the States established water quality standards which were approved by the Secretary of the Interior with some exceptions. Kansas, Nebraska, Missouri, and Iowa adopted standards which generally included secondary treatment or its equivalent for all municipal and industrial wastes except those discharged directly into the Missouri main stem. For the main stem the standards provided that the degree of treatment be determined on the basis of the need to improve water quality. Missouri standards provided for secondary treatment in any event by 1982.

Missouri's standards were approved initially, but the Secretary later insisted that all four States revise their standards to provide for early construction of secondary treatment plants on the main stem. Both Kansas and Iowa stated that, before they would agree to include secondary treatment, they wanted proof that such treatment would result in measurable benefits.

All the States later included secondary treatment along the main stem as a part of their standards, as follows:

--Missouri, by 1982.

--Nebraska, prior to completion of equivalent downstream plants by Kansas and Missouri.

--Kansas, prior to completion of equivalent downstream plants by Missouri or no later than 1985.

--Iowa, by 1975.

The Governor of Kansas, however, protested to the Secretary that the schedule was arbitrary and that, according to professional staff in the Kansas Department of Health, secondary treatment might not be necessary before the year 2000 or later. EPA determined that the above implementation schedules were not acceptable and began contacting cities on the main stem to obtain commitments for installation of

secondary plants. EPA advised officials in four major cities that it was withholding approval of Federal construction grants for pollution abatement projects unless the projects provided for secondary treatment.

For example, in December 1969, EPA approved a Nebraska city's grant application for construction of an interceptor sewer but made payment of grant funds contingent on the scheduling of construction of a secondary treatment plant.

EPA also advised State and local officials that Federal funds would be withheld from sewer projects under programs of the U.S. Department of Housing and Urban Development (HUD). No Federal grant can be made for such HUD projects unless the Administrator of EPA certifies that the sewage will be treated adequately. This means secondary treatment, according to EPA officials.

Iowa deferred setting any dates for secondary treatment until studies showed a need for it. Iowa's water quality criteria stated, in part, that:

> "All municipalities on interior streams will generally need secondary treatment and some already have two stage filtration or other tertiary treatment furnishing up to 96% BOD [biochemical oxygen demand] removal.
>
> "At the present time the Missouri River is in compliance with the criteria since the water quality is not degraded by the discharge of waters receiving primary treatment due to dilution presently afforded. A greater variety of beneficial water uses on the Mississippi River necessitates coliform reduction in addition to primary treatment. Generally a lesser degree of treatment than secondary on these two large streams will not affect the water quality criteria due to the great dilution available."

On November 1, 1969, the Secretary of the Interior, who then had responsibility for water quality standards, announced his intention to impose standards on Iowa which would require secondary treatment plus continuous chlorination for

all wastes by December 31, 1973. On January 9, 1970, Nebraska State and local officials were advised that similar standards would be imposed unless they advanced the construction schedule to the early 1970's.

Finally, on February 28, 1970, at the insistence of EPA, Missouri officials advanced their construction schedule from 1982 to 1975. Since the Missouri plants will be downstream from Kansas and Nebraska, this change also resulted in advanced schedules for those States.

The standards[1] imposed on Iowa became effective June 11, 1970, but the Governor of Iowa protested and requested a formal hearing. Subsequently, in June 1971, agreement was reached with EPA to require secondary treatment by December 31, 1975.

## SUGGESTED ALTERNATIVE TO ADOPTION OF SECONDARY TREATMENT AS STANDARD

Officials of the States bordering the main stem stated a belief that the water quality of the stream below the source of pollution should determine the degree of treatment required. These officials contend that the specified removal of 85 percent of organic matter through secondary treatment of sewage is not an appropriate water quality standard. They expressed willingness to provide whatever treatment would be necessary to protect the water quality and pointed out that secondary treatment might not be sufficient.

For example, such large, swift streams as the Missouri have an enormous capacity to decompose organic materials without impairment of required water quality. In contrast, in small, interior streams bordering highly urbanized and industrialized areas, the organic matter still remaining after secondary treatment may be sufficient to cause a significant pollution problem.

---

[1] Iowa is the only State on the Missouri required to provide a minimum 90-percent reduction of biochemical oxygen-demanding wastes. Other States' standards have been approved at 85 percent.

## CHAPTER 3

## SUITABILITY OF MISSOURI RIVER FOR ITS APPROVED USES

The States' water quality standards specify that the main stem be used for limited recreation, public water supply, commercial fishing, navigation, industry, and irrigation. Of prime relevance to the question of the need for secondary sewage treatment are the recreational, water supply, and commercial-fishing uses. We found that the Missouri River was not considered suitable for recreational use because of its treacherous currents and high turbidity. Furthermore, the Missouri is not deficient as a source for a public water supply and tests indicate that, in most areas of the river, fish flavors are not adversely affected by the existing conditions.

### RECREATIONAL USE

An EPA report on the uses of the main stem states that swimming is not considered a common activity on the main stem due to dangerous water conditions and high turbidity. The report states also that many boaters have suffered engine failures caused by silt present in the waterway.

The river is channeled for navigation, and, because of its treacherous currents, State and local officials whom we contacted considered it too dangerous for body contact recreation. They said that its turbidity also made it unsuitable. For these reasons the recreational use of the main stem can be assumed to be limited to boating, fishing, and general aesthetic enjoyment. A significant factor in determining the aesthetic quality of a waterway is the amount of oxygen in the water. Low oxygen content causes the water to take on an unsavory appearance and odor.

Although EPA has never made a comprehensive all-season study of the main stem, studies that have been made show that there is no dissolved-oxygen problem in the Missouri main stem with existing levels of sewage treatment.

The studies show that, as the water flows downstream, there is no significant decrease in dissolved oxygen due to

the discharge of municipal wastes into the river. For example, in October 1968, single daily samples were taken at 21 points along the main stem during 8 days of dry weather and 2 days following heavy rainfall. Analysis of the samples included determinations of concentrations of oxygen-demanding materials and dissolved oxygen. The dry-weather samples showed that, in some sections of the river, an increase in dissolved-oxygen concentration was recorded between two points although untreated sewage from some industries and municipalities presumably was being discharged into those sections of the river.

Compared with the dry-weather samples, the wet-weather samples showed much higher concentrations of oxygen-demanding wastes and corresponding decreases in dissolved oxygen. During this entire period, however, the dissolved oxygen never fell below five parts for each million, the standard established as necessary to support aquatic life and to prevent nuisance. The dissolved-oxygen concentrations found in both the dry-weather and the wet-weather samples are shown on the graph on page 16.

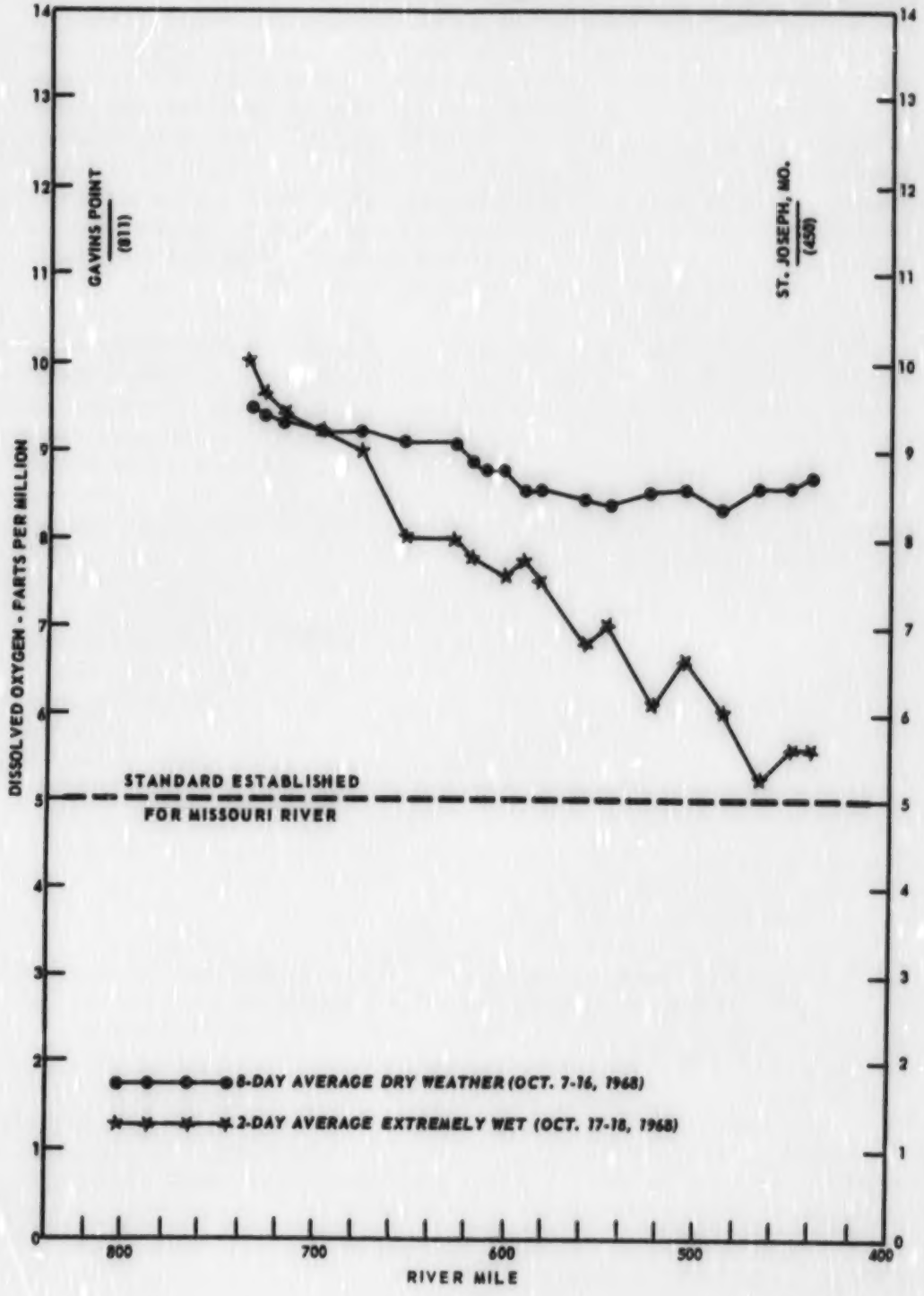
The increase in oxygen-demanding wastes in the river during the rainy weather was attributed to the fact that (1) some untreated municipal sewage had entered the stream because the increased flow through the sewer system, resulting from the rains, exceeded the operating capacities of the sewage treatment plants so that some of the sewage had to bypass the treatment plant and had to enter the river directly from the sewer system and (2) the rain had caused considerable agricultural runoff, including that from farm animal feedlots.

In the absence of these two conditions, oxygen-demanding wastes would tend to decrease after heavy rains because of greater river flow, which would result in acceleration of the natural decomposition and aeration processes.

EPA concluded that these studies did not indicate a deficiency in dissolved oxygen in the main stem. A similar conclusion was reached in May 1966 by a national sanitary-engineering firm employed by Kansas City, Missouri, to determine the probable effect on water quality of secondary treatment of the city's sewage.

## DISSOLVED OXYGEN

MISSOURI RIVER: SIOUX CITY, IOWA TO ST. JOSEPH, MO.



USE FOR PUBLIC WATER SUPPLY

EPA officials contend that the Missouri River is not an acceptable source for public water supplies, primarily on the basis of the large number of coliform bacteria found in the water. Although coliform bacteria are not harmful to man, their presence in a body of water is viewed as an indication of the possible presence of disease-producing bacteria.

For this reason, as well as the fact that the test for coliform bacteria is relatively easy whereas disease-producing bacteria occur in small numbers and are very difficult to detect, public health authorities have adopted coliform counts as a measure of the sanitary quality of water, even in highly polluted water.

During our review we found that EPA's contention was not supported by cognizant public health or water supply officials in the area. In June 1969 the Public Health Service (PHS), in cooperation with Missouri and Kansas State and local health departments, conducted a study to evaluate the quality of drinking water and the reliability of water supply systems in the six-county metropolitan area of Kansas City.

The adequacy of each system was determined by evaluating the source, treatment, water supply system, operation and maintenance, and surveillance program. Although EPA has identified viruses and pathogenic bacteria in the Missouri, the draft of the water supply study shows that the Missouri is an adequate source of water and that water supply plants produce a safe, quality product.

In addition, PHS officials advised us that they were not aware of any incidence of disease that could be attributed to water supplies from the main stem. Taste and odor problems have been experienced intermittently; however, they have been attributed to improper industrial waste disposal practices, surface runoff from agricultural lands, or naturally occurring biological conditions.

## COMMERCIAL FISHING

To permit a viable commercial-fishing industry on a waterway, it is essential that oxygen present in the water be sufficient to permit aquatic life to thrive and that the water not contain material that will adversely affect the flavor of fish and thus render them unmarketable. As cited above in the discussion of the suitability of the main stem for limited recreation, oxygen in the river is not thought to be deficient except during periods of heavy rainfall.

With regard to the question of whether the water of the main stem is free of material that would adversely affect the flavor of fish caught there, EPA conducted a test and reported the results in May 1970. The test, which was designed to identify fish-tainting problems resulting from municipal waste discharges, consisted of tasting fish that had been caged at various points along the main stem. Officials of the EPA Missouri Basin Regional Office contend that the report supports a need for improvement in the quality of water in the main stem.

The data underlying the report showed, however, that the flavor of the caged fish was less than acceptable in only 26 miles of about 740 miles of the stream tested. Flavor was damaged where fish had been caged near the banks below the discharges of slaughterhouses, power plants, and municipalities. In some cases fish caged directly across the river from some discharge points were not tainted, and those caged several miles downstream from sewage discharges were not tainted.

For example, testers rated the flavor of fish caged on the left bank below Omaha as poor but rated the flavor of the fish caged 2 miles downstream on both banks as good. Moreover testers were rating the flavor of fish caged for 4 days where they received the most effect from municipal and industrial discharges.

## CHAPTER 4

## LIMITED BENEFITS FROM CONSTRUCTION OF SECONDARY TREATMENT PLANTS

As mentioned in chapter 2, the need for sewage treatment historically has been based on the lack of sufficient dissolved oxygen in the receiving waters. To this basic justification for secondary treatment, EPA has, in the case of the Missouri main stem, added the argument that such treatment is required to prevent the introduction of disease-producing bacteria into the waterway.

Thus, during our review, which was concerned with the benefits and costs related to the construction and operation of secondary treatment plants along the main stem, our primary focus was on the impact of secondary treatment plant construction, on the oxygen content of the main stem, and on the public health implications related to the bacteria question. We found that the dissolved-oxygen level in the main stem would not be improved significantly by the construction of secondary treatment facilities. We found also that the coliform level would not be reduced significantly by such treatment.

### IMPACT ON OXYGEN CONTENT OF MAIN STEM

As shown in chapter 3, indications are that, under existing levels of sewage treatment, there is not a dissolved-oxygen deficiency in the main stem although, during periods of heavy rainfall, oxygen levels are reduced significantly. The oxygen decrease during such periods has been attributed to the entering of untreated sewage into the stream as a result of the overloading of treatment plants and various kinds of land runoff.

The treatment plants became overloaded during periods of heavy rains because some cities along the main stem had combined storm and sanitary sewer systems. The volume of flow is so great during such periods that the capacity of the treatment plants is exceeded. To preclude damage to plants and equipment, the excess flow is permitted to

discharge directly into the stream without treatment and carries with it untreated sewage and wastes that have accumulated in streets, alleys, and industrial areas. The magnitude of this problem is exemplified by a $250 million estimate of the cost of separating the sanitary and storm sewers in one city.

It appears that the construction and operation of secondary sewage treatment plants would not be of significant value in avoiding the oxygen reduction related to the overloading of treatment plants, since the secondary plants would be sized to accomodate the same assumed flow levels as those of existing primary treatment plants. Similarly secondary treatment would not serve to prevent the deleterious effects of land runoff, since this source of pollution is associated primarily with rural agricultural areas and thus would not be affected by an upgrading of municipal sewage treatment systems. The kinds and magnitude of pollution resulting from land runoff are discussed later in this chapter.

## IMPACT ON DISEASE-PRODUCING BACTERIA

In view of the satisfactory quality of water supplies presently provided by the main stem, our examination into the benefits of reducing coliform levels, and thus those of disease-producing bacteria, explored the question of whether secondary sewage treatment might permit a reduction in the degree, and the associated cost, of water treatment required by municipal water supply systems. We found, however, that such benefits would not ensue.

Water supply officials in the four States have advised us that water supply plants on the main stem purify water under procedures based on the assumption of obtaining the lowest quality from the river. EPA officials advocate secondary treatment and disinfection of sewage to provide some additional, but nonquantifiable, protection to public health.

The water supply officials said, however, that this sewage treatment would have no effect on their plant operation. For example, the water would have to be chlorinated regardless of whether municipal wastes received secondary

treatment. They informed us that the water supply systems had built-in safety barriers and that coliform levels in the Missouri did not pose any special problems that could be satisfactorily treated by the water supply plants.

In the opinion of water supply officials, although coliform levels do not pose any insurmountable problems, indications are that the levels in the main stem are considerably above those considered safe. The previously mentioned water samples taken by EPA in October 1968 showed that, in both dry and wet weather, coliform concentrations had exceeded the EPA-stipulated maximum permissable levels for waterways serving as public water supply sources. The EPA-stipulated maximum levels are one half as high, or, in other words, the standards are twice as stringent, as those established by PHS. A comparison of these criteria is shown below.

| | PHS | EPA |
|---|---|---|
| Total coliform for each 100 milliliters | 20,000 | 10,000 |
| Fecal coliform for each 100 milliliters | 4,000 | 2,000 |

EPA used the dry-weather October 1968 water samples to estimate the impact, on coliform levels, of constructing and operating secondary treatment plants. These estimates showed that secondary treatment would result in a lowering of coliform levels to below the EPA-stipulated maximums. We reviewed these estimates and concluded that, in view of their omission of significant factors, the estimates were not reliable. We discussed the omissions with EPA officials who agreed that the estimates could be misleading and that, if different assumptions had been made, the calculations would have shown significantly different results.

Perhaps the most important factors bearing on the reliability of the estimates is the small number of samples on which they were based and the absence from those samples of any data on all-season concentrations. Additionally the EPA estimates were based on the assumption that the coliform concentrations found in the samples could be attributed almost exclusively to industrial and municipal wastes and thus could be expected to be significantly reducible through

the initiation of secondary sewage treatment and chlorination.

This assumption appeared questionable in view of the many other coliform sources present in the main stem. Data accumulated from the samples indicated that, of the fecal coliform bacteria in the stream (which generally are regarded as more reliable indicators of the presence of disease-producing bacteria than are other coliforms), only about 50 percent were accounted for by measured industrial and municipal wastes.

If EPA had explicitly considered the coliform die-off rate,[1] it might have become apparent that sources other than the measured industrial and municipal wastes must have been contributing to the coliform concentrations found in the samples. If consideration had been given to sources other than industrial and municipal wastes, the estimates would have shown coliform concentrations above the standard even if the sewage received secondary treatment and chlorination before discharge.

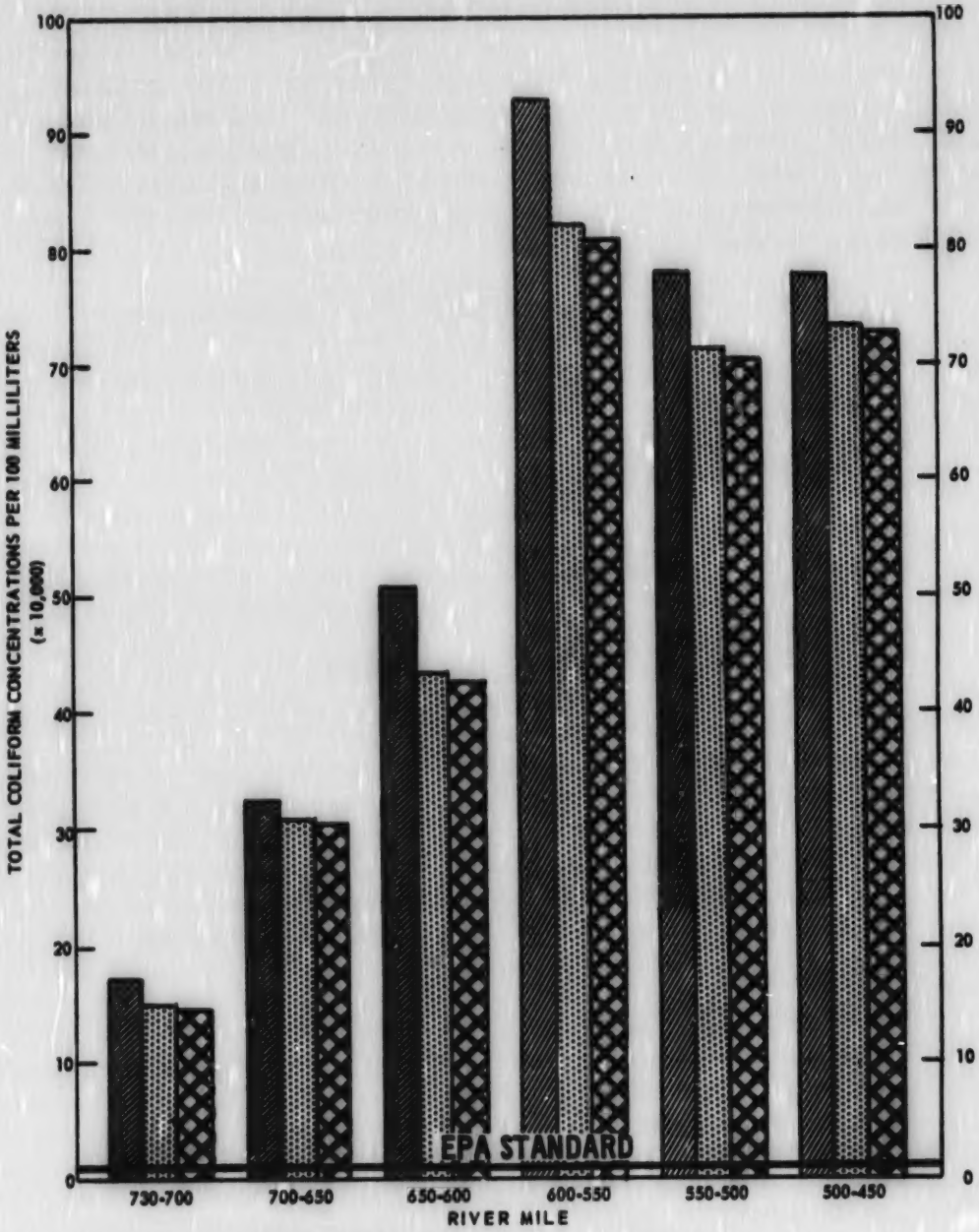
The 2-day wet-weather concentrations were much higher than the 8-day dry-weather concentrations. We used this data and EPA's method for estimating coliform concentrations, except that we made adjustments for the die-off rate and for sources other than those identified with major cities. The results of this estimate, which are presented graphically on page 23, showed that coliform bacteria would have substantially exceeded the EPA standard during the wet weather even if sewage had been given secondary treatment and chlorination.

---

[1]The die-off rate is the rate at which coliform bacteria die after reaching the water. Data developed in earlier investigations on the main stem shows that about one half die within 1 day after entering the stream and that about 70 percent die within 2 days.

For example, if 100,000 coliform bacteria entered the stream at point A and if a measurement were taken downstream 1 day later, it would be expected that about 50,000 coliform bacteria of those entering at point A still would be present. If the downstream measurement, in fact, showed substantially more than 50,000 present, it could reasonably be concluded that sources other than point A had contributed coliform bacteria.

## MEASURED AND PREDICTED COLIFORM CONCENTRATIONS




MISSOURI RIVER SURVEY: OCT. 17-18, 1968
EXTREMELY WET WEATHER, HIGH FLOWS (GAO COMPUTATIONS)

*MEASURED AVERAGES*

*PREDICTED AVERAGES WITH SECONDARY TREATMENT*

*PREDICTED AVERAGES WITH SECONDARY TREATMENT PLUS CHLORINATION*

## AGRICULTURE-RELATED POLLUTION

State and local officials have contended that agriculture-related pollutants from natural runoff affect the water quality of the Missouri River to a far greater extent than do effluents from primary-treated municipal and industrial wastes along the main stem. They reason that any expected enhancement in water quality from secondary treatment will be obscured by the magnitude of pollutants from agricultural sources.

Agricultural and other wastes that enter streams through natural runoff generally are categorized as (1) silt from soil erosion, (2) fertilizers, mainly phosphorous and nitrogen compounds, (3) pesticides, and (4) organic wastes from feedlots. The major concerns to pollution abatement officials along the main stem are silt from soil erosion, sedimentation, pesticide runoff from agricultural lands, and organic waste from large feedlots and from other large feeding operations. A discussion of the status of research into means of abating these pollutants is included as appendix II.

## SILT FROM SOIL EROSION AND SEDIMENTATION

The pollutant causing the greatest damage to Missouri River water quality is sediment. Causes are many and varied and may result from improper farming practices, stream bank erosion, road construction, and other factors. Information obtained from the Omaha District, U.S. Corps of Engineers indicates that 334,000 tons of inorganic sediment is carried into the Mississippi River by the Missouri River each day and that about 99 percent of this load is due to land erosion.

The sediment-contributing areas of the Missouri River have been reduced from about 530,000 to about 150,000 square miles by the construction of large reservoirs. Such reservoirs reduce the sediment load carried by the river by trapping; however, the sediment rapidly fills the reservoirs and thereby reduces their storage capacities.

Silt affects the water quality chiefly by screening out light, by changing heat radiation, by blanketing the bottom of the stream, and by retaining organic materials

and other substances that can create unfavorable conditions for aquatic life. Such conditions possibly can damage the commercial fishing industry, and they have affected the esthetic value of the Missouri and have caused it to be called the Big Muddy.

The principal concerns today, however, seem to be the damage that silt causes to municipal and industrial water supply systems and the cost of removing the silt from water supplies. Certain organic compounds which sometimes are associated with the high sediment load also may require additional costly treatment processes for removal from water supply systems.

## PESTICIDES

Pesticides--including insecticides, herbicides, fungicides, and other like compounds--are particularly toxic to fish and may cause death among birds and mammals. A 1964 report listed the Corn Belt States as the heaviest users of pesticides in the Nation. Many of these pesticides have been found to enter waters as part of surface runoff either in runoff water or attached to silt particles.

## ORGANIC WASTES FROM LARGE FEEDING OPERATIONS

Nearly 90 percent of the cattle from feedlots having capacities of 1,000 head or more come from 10 States west and south of the Missouri River. In seven States farm animals create waste estimated to be equivalent to that of between 220 and 370 million persons. EPA estimates that the stream pollution from all farm animals is equivalent to the wastes of about 18 million persons. The Agricultural Research Service (ARS), by considering a smaller land area and estimates of the amount of wastes being intercepted and naturally degraded by dammed waters in the basin, estimates that feedlot pollution reaching the main stem is equivalent to the wastes of about 2 million persons.

Both feedlot runoff and municipal wastes are organic and create similar responses in, and consequently degradations to, the water. The extent and distribution of feedlot pollution is unknown, and the present state of knowledge does not permit an adequate estimate of the number or types

of control facilities that would be needed to control such wastes. Several states in the Missouri River Basin (Kansas, Nebraska, and Iowa), however, have adopted regulations and have implemented programs to abate pollution from livestock feeding operations.

## PRIORITY GIVEN SECONDARY TREATMENT WILL DELAY MORE URGENTLY NEEDED PROJECTS

Although most cities are operating primary treatment plants along the main stem and secondary plants along tributaries, some of the cities' sewage is not treated at all.

Construction of secondary treatment plants along the main stem will delay other water pollution abatement projects that are more urgently needed in the view of State and local officials. These officials cited planned construction projects, expected to cost millions of dollars, that are needed to stop the discharge of raw sewage into the river.

Projects that State officials considered of greater priority than secondary sewage treatment on the main stem included expansion or replacement of existing treatment facilities, construction of new sewer systems to replace leaky systems, and construction of interceptor sewers which would channel wastes not now treated into existing or planned treatment plants. These projects included secondary sewage treatment plants on interior streams and tributaries of the Missouri River which do not have the high velocity and large flow of the river and which thus require secondary sewage treatment to attain approved water quality standards.

As an example of the magnitude of these needs, officials of three large cities on the main stem have furnished us with estimates totaling about $266 million for water pollution abatement projects which they consider necessary. Of this amount, $192 million is required for projects which they consider to have higher priority than secondary treatment plant construction on the main stem.

These costs do not include operating and maintenance (O&M) costs which are much greater for secondary treatment plants than for primary treatment plants. Under present financing plans, the cities must raise all O&M costs plus from 20 percent to 70 percent of the construction costs.

The problems of complying with a policy of providing secondary treatment of sewage discharged directly into the main stem, as viewed by officials of various cities that we visited, are discussed in the following examples.

EPA correspondence files showed that officials of Kansas City, Kansas, agreed to secondary treatment by 1975 after they were informed by HUD and EPA officials that Federal grants for sewers in urban renewal projects would be withheld until the city agreed to provide secondary treatment. The existing treatment plant in this locale removes about 65 percent of oxygen-demanding materials.

We were advised that about $40 million would be needed for pollution abatement projects from 1969 through 1990. Plans call for completing projects totaling $15 million prior to the installation of secondary plants; however, the city now will have to revise its construction schedule, we were told, and will have to expend funds otherwise available for these projects in order to install secondary treatment by 1975.

Four other major municipalities that we contacted on the main stem set as their first priority interceptor sewers to channel all sewage into existing primary plants. In another community officials advised us that the sanitary sewers served only about 40 percent of the homes in the area. They said that the remaining sewage either emptied into septic tanks or flowed directly into a creek which traverses the middle of town to the Missouri River. The creek is an open sewer with feces, green scum, and other offensive materials floating in the water.

We were advised that this condition could be alleviated by the installation of sanitary sewers, extension of city trunk lines to the sanitary sewers, and installation of interceptor sewers to collect and transport raw sewage from the trunk lines to the treatment plant.

In a city having a population of about 78,000, we observed another sewer outfall from which untreated sewage was flowing directly into the Missouri River. City officials advised us that about 30 percent of the sewage was handled this way because another interceptor sewer and pump station

were needed to carry sewage to the primary treatment plant. They estimated the cost of facilities to correct this condition at about $2.5 million. Similar problems exist in cities and towns on interior streams.

## CHAPTER 5

## FEDERAL AND STATE COMMENTS AND OUR EVALUATIONS

Drafts of this report were submitted to EPA and to the States of Iowa, Kansas, Missouri, and Nebraska. Of the two States which responded to our draft report, one was in agreement and the other was noncommital. Written comments obtained from EPA (see app. V) dealt largely with the desirability of adhering to the requirement for secondary sewage treatment along the Missouri River. Subsequently, at a meeting held on September 27, 1971, the Deputy Assistant Administrator of EPA indicated concurrence with our position that other pollution abatement measures should have priority if they would produce greater benefits sooner.

Details of EPA's written comments, our related views, and the subsequent meeting with the Deputy Assistant Administrator are presented below.

### WRITTEN COMMENTS OF ENVIRONMENTAL PROTECTION AGENCY

In discussing the advantages of secondary treatment, EPA commented, in part, that:

> "There are many valuable and tangible attributes associated with secondary waste treatment other than its capacity to remove oxygen-demanding wastes. Most of these are affected little, if at all, by primary treatment. These attributes include up to 95 percent suspended solids reduction and the removal of substantial quantities of bacteria, pathogenic organisms, viruses, heavy metals, and nutrients including 30 percent or greater phosphorous removal and 50 percent nitrogen reduction."

We have never taken the position that secondary treatment of municipal wastes may not be necessary to correct local conditions or to meet the approved uses of a waterway. When secondary treatment does not measurably contribute to those uses, however, it is our position that, in view of the

limited Federal, State, and local funds available, priority should be given to those pollution abatement projects that would provide the most significant improvements. These projects include those needed to stop the discharge of raw sewage. (See ch. 4.)

Our consultants have found that alternatives to secondary treatment exist (such as chemical coagulation processes followed by chlorination) and appear to have lower capital and O&M costs. These processes can remove the materials in question and can disinfect the wastes reaching the waters should this be found necessary to attain the approved water uses. Certain State and local officials, however, contend that any expected enhancement in water quality from secondary or other alternative treatments will be obscured by the magnitude of pollutants from agricultural sources. (See ch. 4.)

EPA commented also that:

> "*** the treatment of public water supplies is based on a concept of multiple barriers against the invasion of pathogenic organisms. One of these barriers is adequate disinfection of municipal wastes that may enter the waterway from which the supply is drawn. *** the processes involved in secondary treatment are effective not only in removing a great number of the pathogenic organisms but also facilitate the destruction of others through dependable, effective disinfection. There are a number of organisms present in sewage that threaten the health of persons drinking or swimming in the water that is so contaminated."

As discussed in chapter 3, we question whether secondary treatment plants, even with disinfection, could make the Missouri River safe for swimming because of the inherent treachery of the stream and because of other major contributing sources of pollution which would not be treated by these plants.

Although we do not question the desirability of establishing multiple barriers for safeguarding the drinking-water supply, EPA studies do not show that pathogenic

organisms in the river would be eliminated completely even after municipal wastes receive secondary treatment and are disinfected. It appears that, if additional protection is needed beyond the multiple barriers already existing at the water supply processing plants, the most effective protection would be at the water intakes where protection could be afforded against all sources of pollution, including those arising from untreated sewage and surface runoff.

EPA also commented on the costs involved, as follows:

> "It is true that the cost of construction of secondary treatment plants is greater than that of primary treatment plants. Since secondary treatment with bacterial control is necessary, however, to comply with established water quality standards *** these facilities must eventually be constructed. Moreover, the complete construction of a total facility is considerably less costly than the separate construction of primary and secondary treatment plants."

This statement is correct if all costs are considered to be incurred in a single year. However, if the costs are time phased, that is, if a primary treatment plant is constructed now and is upgraded by additional construction to secondary treatment at some future date, a part of the cost is deferred. There is a saving on that part of the cost that does not have to be spent now. A computation that we made using the method prescribed in Office of Management and Budget Circular No. A-94 indicated that the savings by delaying the expenditure would nullify the additional cost if the upgrading could be delayed 6 years. (See app. III.)

With this in mind we believe that concentrating on the choices which will provide the most immediate and significant water quality improvements is the most prudent course of action although secondary sewage treatment facilities ultimately may be required.

In regard to the flavor of fish in the Missouri River, EPA commented that:

"*** The presence of unacceptable flavors in fish flesh from caged fish confined downstream from metropolitan areas in the lower Missouri River is a significant indication of the existence of a problem and of the presence of taste and odor producing compounds in the water. Secondary treatment removes those ketones that occur in paint solvents, phenols, hydrocarbons and coal tar wastes that produce the disagreeable taste in fish flesh. Water quality standards adopted by the States specify that water quality should be such that off flavors are not produced in fish flesh."

The EPA statement neglects to say that the results of the fish-flavor study were substantially influenced by wastes from major sources other than the cities' primary treatment plants. As discussed in chapter 3, fish were confined where they would receive the effects from untreated industrial and slaughterhouse wastes. Others were caged immediately below the confluence of tributaries. The States have scheduled and are constructing secondary plants on these tributaries.

We believe that the results of the fish-flavor study support the need for industrial enforcement actions and for abatement projects to prevent untreated sewage from entering the waters. The secondary treatment of municipal wastes on the main stem alone would not alleviate these conditions. Furthermore the study does not specifically identify the substances causing off-flavors in fish flesh except to state, for example:

"The Old Blue River was also toxic ***. Wastes in Sugar Creek *** not only were toxic but also caustic ***."

We have been advised by EPA personnel that secondary treatment is not effective in removing toxic materials. Hence, if these materials are to be removed, other treatment processes would be required.

## SUBSEQUENT MEETING WITH DEPUTY ASSISTANT ADMINISTRATOR OF ENVIRONMENTAL PROTECTION AGENCY

In a subsequent meeting held on September 27, 1971, the Deputy Assistant Administrator of EPA stated that he was in general agreement with our position. As he expressed it the degree of treatment required should include consideration of the characteristics of the receiving waters, all polluting sources affecting those waters, and the intended uses of the waters.

# CHAPTER 6

## CONCLUSIONS AND RECOMMENDATIONS

### CONCLUSIONS

Our findings indicated that requiring the construction of secondary treatment plants along the Missouri main stem would result in significant expenditures of public funds which otherwise might be used to meet more pressing water pollution abatements needs. These needs include projects designed to stop the discharge of raw, untreated sewage into the river by the construction of interceptor sewers and the enlargement of existing plants. Such projects would lead to relatively greater public benefits sooner than would the expenditure of funds for secondary treatment plants.

A major purpose of secondary treatment of sewage is to aid in maintaining a stream's dissolved oxygen at the levels needed to support aquatic life and to prevent nuisance conditions. In the Missouri main stem, this does not appear to be the principal problem because tests show that the dissolved-oxygen levels substantially exceed the minimum levels required except following periods of heavy rain, when the dissolved-oxygen levels decline but still remain above the minimum required. Secondary sewage treatment would have no effect on the sources of pollution that cause the decline in rainy weather.

The immediate cause of the decline in dissolved oxygen following periods of heavy rain is that untreated sewage reaches the river because the increased flow through the sewer systems exceeds the treatment plant capacities so that the excess flows directly into the river in an untreated state. Furthermore the rain results in considerable runoff from the land, carrying pollution from agricultural and construction activities and organic wastes from feedlots into the river.

EPA's advocacy of secondary treatment to reduce concentrations of coliform bacteria also may not be sound. It generally is recognized that the use of coliform bacteria to indicate the presence of pathogenic bacteria or viruses

is rather tenuous. In any event, public water supply systems along the main stem have been determined to provide adequate health safeguards and water supply officials have stated that secondary treatment of sewage probably will not reduce the costs of operating these systems.

Since the main stem is not considered suitable for body contact recreation because of its hazardous currents, secondary treatment would provide no recreational benefits. Even if body contact recreation were an approved use of the main stem, it seems unlikely that secondary treatment would reduce coliform concentrations to required levels, especially during a period of surface runoff.

## RECOMMENDATIONS

We recommend that the Administrator of EPA reconsider the timing of the requirement for secondary treatment of municipal wastes along the Missouri River. Such reconsideration should be made in the light of conditions existing along the river and the nature of the sources of its pollution. We recommend also that the Administrator evaluate whether greater public benefits are attainable sooner from expenditures for pollution abatement projects other than secondary plant construction.

## CHAPTER 7

## SCOPE OF REVIEW

Our review was made to examine into whether it would be to the advantage of the U.S. Government to invest funds in secondary treatment plants on the Missouri main stem from Gavin's Point to St. Louis.

We evaluated information relating to State and Federal water pollution control plans, programs, and water quality standards as they affected the approval of Federal construction grants. We were assisted by consultants having expertise in water pollution control for certain technical matters.

The review was conducted at the EPA Missouri Basin Regional Office in Kansas City, Missouri, and at State water pollution control agencies in Kansas, Iowa, Missouri, and Nebraska. Visits also were made to sections of waterways, municipalities, public health agencies, water treatment plants, and local planning organizations in these States; to the Northern Plains Branch Office of ARS in Fort Collins, Colorado; and to the ARS field office in Lincoln, Nebraska.

We reviewed the States' water pollution control plans submitted to EPA; water pollution control programs as carried out by the States; the States' water quality standards, including criteria and implementation plans; enforcement conference reports; program grant expenditures; and EPA manuals, correspondence, and reports. We held discussions with responsible EPA regional office officials, with officials of State water pollution control agencies as well as of selected municipalities and local planning organizations, and with State and municipal sanitary engineers and public health officials.

APPENDIX I

# EVALUATION OF DEFERRED COSTS FOR UPGRADING TREATMENT PLANTS

In commenting on a draft of this report, the EPA stated that:

> "*** the complete construction of a total facility is considerably less costly than the separate construction of primary and secondary treatment plants ***".

This statement is correct if all the costs are considered to be incurred in a single year. However, if construction is time phased, that is, if a primary treatment plant is constructed now and upgraded by additional construction to secondary treatment at some future time, the future costs are subject to discounting before the total costs can be compared with the alternative of constructing a complete (primary plus secondary) plant now.

Such an analysis is in accordance with the procedures to be used in evaluating deferred costs as stated in Office of Management and Budget Circular No. A-94. The discount rate applied in the example shown in the circular is 10 percent, and this rate was used in analyzing the cost differences between the alternative construction options. The results of these analyses are presented in chapter 5.

Data for construction and O&M costs of sewage treatment plants is obtained by EPA in the course of administering the plant construction grant program. This cost data has been correlated with plant size for various types of treatment plants, so that, for given sewage loads expected in terms of either flow or population served, the relative costs for differing treatments can be determined.

For use in the following analysis, an EPA draft report dated May 14, 1968, was used to obtain construction cost data and a draft dated August 5, 1969, was used for O&M costs. Inasmuch as the construction cost data is in terms of 1957-59 dollars and the O&M cost data is in terms of 1966-68 dollars, construction costs were brought to 1967 dollars by use of the average national sewage treatment plant

construction cost index. As stated in the EPA report, this index is 119.41 (1957-59 = 100) for 1967. Thus construction costs listed in that report are increased by a factor of 1.1941 (nearly a 20-percent increase).

For purposes of comparing costs, it is necessary to choose a specific plant size as well as the specific processes to be compared. Such choices are necessary because costs differ among the various treatment processes and because economies of scale exist for both construction and O&M costs. That is, the unit costs (for each unit of flow or for each unit of population served) are lower for larger plants. For this analysis a plant sized to serve a population equivalent (PE) of 50,000 was chosen because it is of a size that may well serve medium-sized cities and because the unit costs at this size are beginning to decrease quite slowly.

The alternatives compared are:

1. Constructing a primary treatment plant and upgrading it to a sludge-process secondary plant in the future.

2. Constructing a complete (primary plus sludge-process secondary) plant.

The present values of the costs for these alternatives, including O&M costs, were compared when the upgrading was postponed for 5 years and for 10 years. Furthermore the year for which alternative 1 first showed a cost advantage was determined.

The discount factors used were taken from "Tables for the Analysis of Capital Expenditures," published by the Harvard Business School.

Cost Data

| Plant type (note a) | Cost for each PE (1957-59 dollars) | Total O&M costs (1966-68 dollars) |
|---|---|---|
| Primary | $15.84 | $67,300 |
| Complete (primary and sludge process) secondary | 21.50 | 98,200 |
| Upgrade (primary to sludge process) | 12.57 | - |

[a]Plant size: 50,000 PE.

APPENDIX I

## Discount Factors (10-percent rate)

| Year | Discount factor or present value of $1 | Cumulative discount factor or present value of $1 a year received at end |
|---|---|---|
| 1 | 0.90909 | 0.90909 |
| 2 | .82645 | 1.7355 |
| 3 | .75131 | 2.4869 |
| 4 | .68301 | 3.1699 |
| 5 | .62092 | 3.7908 |
| 6 | .56447 | 4.3553 |
| 7 | .51316 | 4.8684 |
| 8 | .46651 | 5.3349 |
| 9 | .42410 | 5.7590 |
| 10 | .38554 | 6.1446 |

## Computations

| Construction | Unit costs (note a) 1957-59 dollars | Unit costs (note a) 1967 dollars | Cost for 50,000 PE |
|---|---|---|---|
| Primary | $15.84 | $18.91 | $ 945,500 |
| Complete | 21.50 | 25.67 | 1,283,500 |
| Upgrading | 12.57 | 15.01 | 750,500 |

### Present Value of Upgrading at Year Listed

| Year | Discount factor | Present value |
|---|---|---|
| 0 | 1.0000 | $750,500 |
| 5 | .62092 | 466,000 |
| 6 | .56447 | 423,635 |
| 7 | .51316 | 385,127 |
| 8 | .46651 | 350,116 |
| 9 | .42410 | 318,287 |
| 10 | .38554 | 289,348 |

[a]Inflation factor: 1.1941.

APPENDIX I

## Present Value of Cumulative O&M Costs for Listed Year

| Year | Cumulative Discount factor | Present value: Primary plant ($67,300 a year) | Present value: Complete plant ($98,200 a year) |
|---|---|---|---|
| 5 | 3.7908 | $255,121 | $372,257 |
| 6 | 4.3553 | 293,112 | 427,690 |
| 7 | 4.8684 | 327,643 | 478,077 |
| 8 | 5.3349 | 359,039 | 523,887 |
| 9 | 5.7590 | 387,581 | 565,534 |
| 10 | 6.1446 | 413,532 | 603,400 |

When O&M costs are included in the analysis, the point at which the two alternatives have equal costs may be found by a trial-and-error process. As shown in chapter 5, the alternative of postponing the upgrading is very little more expensive at 5 years. Thus, if we consider the costs at 6 years, the situation reverses and postponement is the more economical alternative, as shown below.

| | Cost | Discount factor | Present value (nearest $1,000) | |
|---|---|---|---|---|
| Primary plant | $ 945,500 | 1.0 | $ 946,000 | |
| 6 years O&M | 67,300[a] | 4.3553 | 293,000 | |
| Upgrading | 750,500 | .56447 | 424,000 | |
| Present value if upgraded in 6 years | | | | $1,663,000 |
| Complete plant | $1,283,500 | 1.0 | 1,284,000 | |
| 6 years O&M | 98,200[a] | 4.3553 | 428,000 | |
| Present value of complete plant for 6 years | | | | 1,712,000 |
| Net difference | | | | $ -49,000 |

[a]A year.

It may be seen that upgrading in 6 years is more economical by $49,000 than building and operating the complete plant for that period of time.

## STATUS OF RESEARCH ON POLLUTION FROM AGRICULTURAL SOURCES

In January 1969 the Secretary of Agriculture and the Office of Science and Technology submitted a report to the President outlining a 5-year action and research and development program of Federal agencies on agriculture-related pollution. It was estimated that over $6 billion would be needed in the next 5 years for agricultural pollution abatement.

On March 20, 1969, the Research Committee of the Great Plains Agricultural Council listed the following agriculture-related water pollution problems that required increased research attention in the Great Plains.

--Management of sediment production from agricultural lands.

--Disposal of animal wastes.

--Control or prevention of soil and water pollution from fertilizers.

--Control of pesticides, radioactive materials, and heavy metals and methods for decontamination of soils, waters, and plants.

--Development of more reliable predictions, including mathematical models, of runoff and stream flow.

--Evaluation and prediction of sediment amounts and sources.

--Development of land treatment measures for minimizing erosion and for controlling runoff.

--Availability of nutrients from crop residues and animal wastes.

--Use of food processing and municipal, industrial, and other effluents for irrigating crops.

APPENDIX II

EPA recognizes its responsibility for abating all types of pollution affecting interstate waters, including that relating to natural and agricultural activities, and its need to coordinate and cooperate with other Government agencies in research work. EPA regional officials have advised us, however, that a shortage of funds and manpower has restricted this work in the Missouri River Basin. Instead EPA has emphasized its program for construction of secondary treatment plants by the mid-1970's.

In October 1969 EPA regional officials advised us that little effort had been extended in the area of agricultural pollution problems in the Missouri River Basin because they considered these problems to be primarily the responsibility of State pollution control authorities. They said that a comprehensive study of agriculture-related water pollution problems was needed but that such problems should not delay EPA programs to control municipal wastes.

We were not able to determine, at the Missouri Basin Regional Office, the extent to which ARS was involved in agriculture-related pollution questions. We therefore visited the ARS field office in Lincoln and noted several research projects on feedlot pollution under way in cooperation with the University of Nebraska's Agricultural Engineering Department.

One project was for the development of engineering data for design and management of runoff control facilities, and another project was for the development of economically feasible methods for removing solids from feedlot runoff. No definite conclusions had been reached on any phase of this work. The chief of the research team said that tests on the activated-sludge method of secondary treatment had resulted in less than a 50-percent removal of oxygen-demanding materials and that this method of treating feedlot wastes might not be practical.

We also visited the Northern Plains Branch Office of ARS in Fort Collins. This branch was conducting seven agricultural pollution research programs totaling about $670,000, or about 31 percent of the total $2.2 million allotted to the branch for all research activities in the Missouri Basin Region.

In January 1970 EPA began sharing the research costs of a cattle feedlot waste management program with ARS. EPA's annual share in the project for the next 3 years is $152,000. This was the only research activity requested of ARS by the Missouri Basin Region. The objective of the project was to determine the extent and kinds of microbial, chemical, and organic pollutants entering the atmosphere, soils, and surface and underground water supplies from cattle feedlots in two contrasting climatic zones (northern Colorado with annual precipitation of 14 to 15 inches and eastern Nebraska with annual precipitation of 27 to 28 inches). It appears that this project does not address the problem of preventing raw feedlot wastes from entering the streams.

APPENDIX III

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 28 1971

OFFICE OF THE
ADMINISTRATOR

Mr. Lloyd Smith
Associate Director
United States General Accounting Office
Washington, D. C. 20548

Dear Mr. Smith:

I appreciate the opportunity to comment on a draft report to the Congress of the United States on "Limited Benefits Expected from Construction of Secondary Waste Treatment Facilities Along the Missouri River" prepared by the Comptroller General of the United States.

[See GAO note, p. 47.]

The report questions the need for secondary waste treatment along the Missouri River, and dwells upon the abundance of oxygen within this particular receiving waterway. There are many valuable and tangible attributes associated with secondary waste treatment other than its capacity to remove oxygen-demanding wastes. Most of these are affected little, if at all, by primary treatment. These attributes include up to 95 percent suspended solids reduction and the removal of substantial quantities of bacteria, pathogenic organisms, viruses, heavy metals, and nutrients including 30 percent or greater phosphorous removal and 50 percent nitrogen reduction. The receiving waters of efficiently treated wastes are kept aesthetically clean. A very important factor is that secondary treatment provides the basis for efficient, effective

disinfection through the removal of most of the solid particles that harbor bacteria and by destruction of fecal organic matter in which they multiply. To strive for less than secondary waste treatment or its equivalent is to strive towards mediocrity when something far superior is attainable, technically realistic and needed to protect water uses.

We concur in the GAO position that primary treatment plants do provide some degree of pollution abatement. It is evident that, if there must be a choice between primary treatment or no treatment, primary treatment, though inadequate, is preferable.

[See GAO note, p. 47.]

Data collected during investigations made of the Missouri River and its tributaries by the FWQA over the past two years demonstrate conditions of serious pollution. Wastes discharged by the major communities, using only primary treatment, cause measurable increases in bacterial indicator organisms, virus and fecal sterols. These wastes also cause water quality degradation as reflected by the structure of the periphyton communities and the tainting of fish flesh. Each measured pollutional characteristic or observed effect is attributable to constituents that can be removed from waste waters by properly operated secondary treatment facilities with bacterial control.

This investigation also provided specific knowledge on a number of pollutants that should be prevented from entering the Missouri River and that can be controlled by secondary treatment with disinfection. For example, the treatment of public water supplies is based on a concept of multiple barriers against the invasion of pathogenic organisms. One of these barriers is adequate disinfection of municipal wastes that may enter the waterway from which the supply is drawn. As stated previously, the processes involved in secondary treatment are effective not only in removing a great number of the pathogenic organisms but also facilitate the destruction of others through dependable, effective disinfection. There are a number of organisms present in sewage that threaten the health of persons drinking or swimming in the water that is so contaminated. These include: Salmonella; Shigella; Leptrospira; Mycobacterium; and the enteric viruses, such as polio and hepatitis.

The FWQA investigations on the Lower Missouri River resulted in the isolation of a number of constituents that can be removed by

secondary treatment. These included 19 Salmonella serotypes and many of these were pathogenic human strains. Pathogenic Salmonella were demonstrated in three water supply intakes. Bacterial regrowth was found to be significant in the receiving waters. Viruses were isolated from sewage effluents during the study. Some were isolated from water supply intake areas. It was demonstrated that viruses could survive in Missouri River water for a period of 25 hours or longer, which would permit them to reach most water supply intakes from the pollution source. In laboratory experiments, they survived in large numbers.

Fecal sterols were isolated from water intake areas during the survey. The isolation of fecal sterols confirmed independently with a chemical test rather than a bacteriological one that fecal pollution does occur. These are biodegradable and would be removed in a secondary treatment process.

The Fish-tainting study was not a unique or alternate approach to a comprehensive water quality investigation, but one that has been used on a number of occasions to successfully identify taste and odor problems in water. The presence of unacceptable flavors in fish flesh from caged fish confined downstream from metropolitan areas in the lower Missouri River is a significant indication of the existence of a problem and of the presence of taste and odor producing compounds in the water. Secondary treatment removes those ketones that occur in paint solvents, phenols, hydrocarbons and coal tar wastes that produce the disagreeable taste in fish flesh. Water quality standards adopted by the States specify that water quality should be such that off flavors are not produced in fish flesh.

It is true that the cost of construction of secondary treatment plants is greater than that of primary treatment plants. Since secondary treatment with bacterial control is necessary, however, to comply with established water quality standards for the Missouri River and to safeguard the water supply for some 3,000,000 people using it as a source of drinking water, these facilities must eventually be constructed. Moreover, the complete construction of a total facility is considerably less costly than the separate construction of primary and secondary treatment plants.

I am enclosing a copy of "The Case for Better Waste Treatment" prepared by the Water Quality Office's Regional Director in Kansas City, Missouri. This report demonstrates the viability of the Federal policy requiring a minimum of secondary treatment and bacterial control in the Lower Missouri River for all waste sources. I am informed that you have previously received a copy of this report and that technical data and reports that were prepared as a result of Federal surveys of this river and its problems have been available to you.

We would appreciate an opportunity to discuss our waste treatment policy with you at your convenience.

Sincerely,

Thomas C. Carroll
Assistant Administrator
for Planning and Management

Enclosure

GAO note: The omitted sections discuss matters no longer pertinent to this report.

APPENDIX III

Iowa
# State Department of Health

LUCAS STATE OFFICE BUILDING
DES MOINES, IOWA 50319

ARNOLD M. REEVE, M.D., M.P.H.
COMMISSIONER OF PUBLIC HEALTH

Environmental Engineering Service

P. J. Houser, M.S., P.E., Chief

February 2, 1971

Mr. Arnett E. Burrow
United States General Accounting Office
1800 Federal Office Building
911 Walnut Street
Kansas City, Missouri 64106

Dear Mr. Burrow:

Enclosed are comments regarding the General Accounting Office report on limited benefits from construction of secondary waste treatment facilities along the Missouri.

Suggestions regarding changes have been rather minor but may improve or clarify a number of thoughts.

You will note agreement has been reached with FWQA requiring secondary treatment for Sioux City and Council Bluffs had earlier reached agreement with FWQA in order to secure release of HUD funds.

These comments and other data have been furnished to the Governor's office.

We are in general agreement with the philosophy expressed in the report and are hopeful it may be helpful in permitting assigning a priority to projects with much greater need on interior Iowa streams. At present arbitrary completion dates have been assigned to the large border stream projects and at current State and Federal funding rates little or no funds will be available for other projects.

Sincerely,

R. J. Schliekelman
Director
Water Pollution Division

RJS:vm
Enc.

Warren E. Hearnes
Governor

Executive Office
Jefferson City
Missouri

February 2, 1971

Mr. Allen R. Voss
Associate Director
United States General Accounting Office
Washington, D. C.

Dear Mr. Voss:

We appreciate the opportunity to review the draft copy of "Limited Benefits Expected From Construction of Secondary Waste Treatment Facilities Along the Missouri River". The report is based upon economic consideration and we question whether or not this is the only factor to be considered in requiring secondary treatment of waste discharges to the Missouri River.

The first sentence on Page 10 is not entirely correct in that there are other persons considerably interested, and others that recommended the Board advance the date for the construction of secondary treatment. It is true that the Federal Water Quality Administration requested that the Board advance the date.

The second sentence on Page 18 is incorrect. I know of no other city that has a similar problem to the one mentioned.

I appreciate the opportunity to review this report, and wish to state that in general it is thorough.

Sincerely yours,

Warren E. Hearnes

WEH:dw

APPENDIX IV

## PRINCIPAL OFFICIALS OF THE ENVIRONMENTAL PROTECTION AGENCY RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES DISCUSSED IN THIS REPORT

(as of July 1, 1971)

| | Tenure of office | |
|---|---|---|
| | From | To |
| ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY (note a): | | |
| William D. Ruckelshaus | Dec. 1970 | Present |
| SECRETARY OF THE INTERIOR: | | |
| Walter J. Hickel | Feb. 1969 | Nov. 1970 |
| Stewart L. Udall | Jan. 1961 | Jan. 1969 |
| ASSISTANT SECRETARY FOR WATER QUALITY AND RESEARCH (note b): | | |
| Carl L. Klein | Mar. 1969 | Oct. 1970 |
| Max N. Edwards | Dec. 1967 | Feb. 1969 |
| Frank C. DiLuzio | July 1966 | Dec. 1967 |
| COMMISSIONER, WATER QUALITY OFFICE: | | |
| David D. Dominick | Mar. 1969 | Present |
| Joe G. Moore, Jr. | Feb. 1968 | Mar. 1969 |
| James M. Quigley | Mar. 1966 | Jan. 1968 |

[a]The Federal Water Pollution Control Administration was transferred from the Department of Health, Education, and Welfare in May 1966, and the title of the agency was changed to the Federal Water Quality Administration in April 1970. Effective December 2, 1970, the Federal Water Quality Administration was transferred from the Department of Interior, its name was changed to the Water Quality Office, and its functions were incorporated into the newly established EPA.

[b]Designated as Assistant Secretary for Water Pollution Control until October 1968.



U.S. GAO, Wash., D.C.